The Association for Professionals in Infection Control and Epidemiology (APIC)

New Mexico Chapter

2025 Annual Conference

Sheraton Albuquerque Uptown

Tuberculosis for the Infection Preventionist

28 March 2025

Carlos M. Perez-Velez, MD, DTM&H

Infectious Diseases Physician and Hospital Epidemiologist, NMVAHCS

Associate Professor of Clinical Medicine, U. of New Mexico and U. of Arizona

Carlos.Perez-Velez@VA.gov

Relevant Disclosure of Conflicts of Interest

I, Carlos M. Perez-Velez, have ***no*** actual or potential financial (direct or indirect) or non-financial (professional/intellectual or personal) conflicts of interest that relate to this presentation.

Contributor Acknowledgments

Claudia L. Roya-Pabón, MD
for her insightful feedback and editorial assistance

Objectives

- *Briefly* review…
  - current **epidemiology** of tuberculosis (TB) disease
  - **transmission** of *Mycobacterium tuberculosis*
  - **pathogenesis and natural history** of TB
- Review the **infection prevention & control of TB**
  - In health-care facilities
  - In the community

General References: TB-IPC

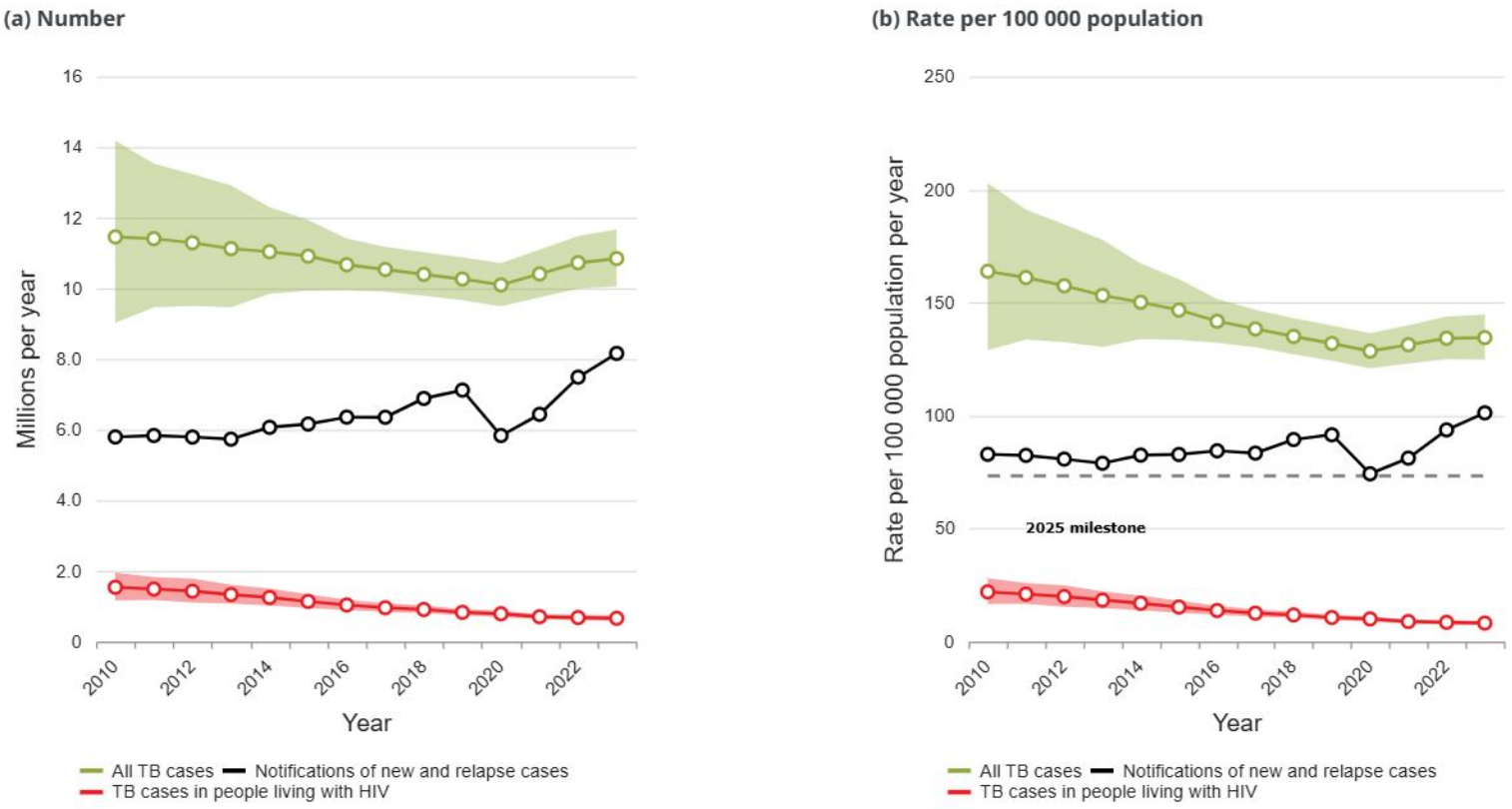
- Zachary KC. "Tuberculosis transmission and control in health care settings." 2025 (Feb). In: ***UpToDate***, Connor RF (Ed), Wolters Kluwer.
- **Curry International Tuberculosis Center**. *Tuberculosis Infection Control: A Practical Manual for Preventing TB*. Second Edition. 2024.
- WHO. *Operational Handbook on Tuberculosis. Module 1: Prevention - Infection Prevention and Control*. Geneva: **World Health Organization**. 2023.
- Stevens M. "Tuberculosis." 2018 (Jan). In: **International Society for Infectious Diseases** (Ed.). *Guide to Infection Control in the Healthcare Setting*. pp. 1-8.
- Cadena-Zuluaga J. "Tuberculosis and Other Mycobacteria." 2014 (Oct). In: Dean R, Popescu S (eds.). ***APIC Text***. 2020.
- Jensen, Paul A et al; **Centers for Disease Control and Prevention (CDC)**. “Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care settings, 2005.” *Morbidity and Mortality Weekly Report. Recommendations and Reports*. 2005. 54(RR-17):1-141.

TB Epidemiology

Epidemiology: Why should you be interested in this topic?

Fig. 1.1.1 Global trends in the estimated number of incident TB cases (a) and the incidence rate (b), 2010–2023

Shaded areas represent 95% uncertainty intervals. The horizontal dashed line shows the 2025 milestone of the End TB Strategy, which is a 50% reduction in the TB incidence rate between 2015 and 2025.



Why should you be interested in this topic?

PBS NEWS

Menu

By — Karen Dobos, The Conversation

By — Marcela Henao-Tamayo, The Conversation

Leave your feedback

Tuberculosis was once a disease in decline, but a resurgence in cases has health officials puzzled

Health Mar 23, 2025 1:38 PM EDT

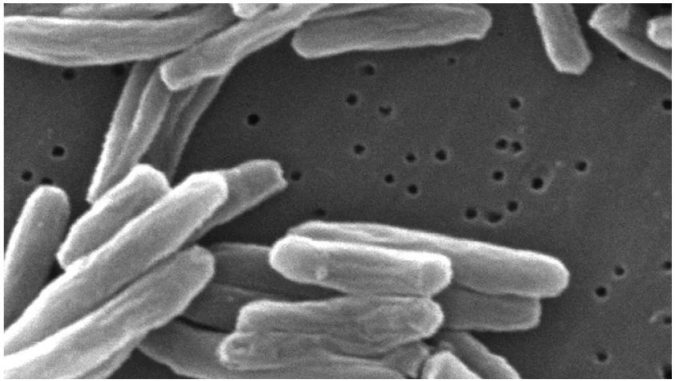
MEDPAGETODAY

Infectious Disease > Tuberculosis

U.S. Tuberculosis Cases Rose to Their Highest Levels in More Than a Dozen Years

— Over 10,300 cases were reported last year

by Associated Press
March 21, 2025



(Janice Carr/CDC via AP)

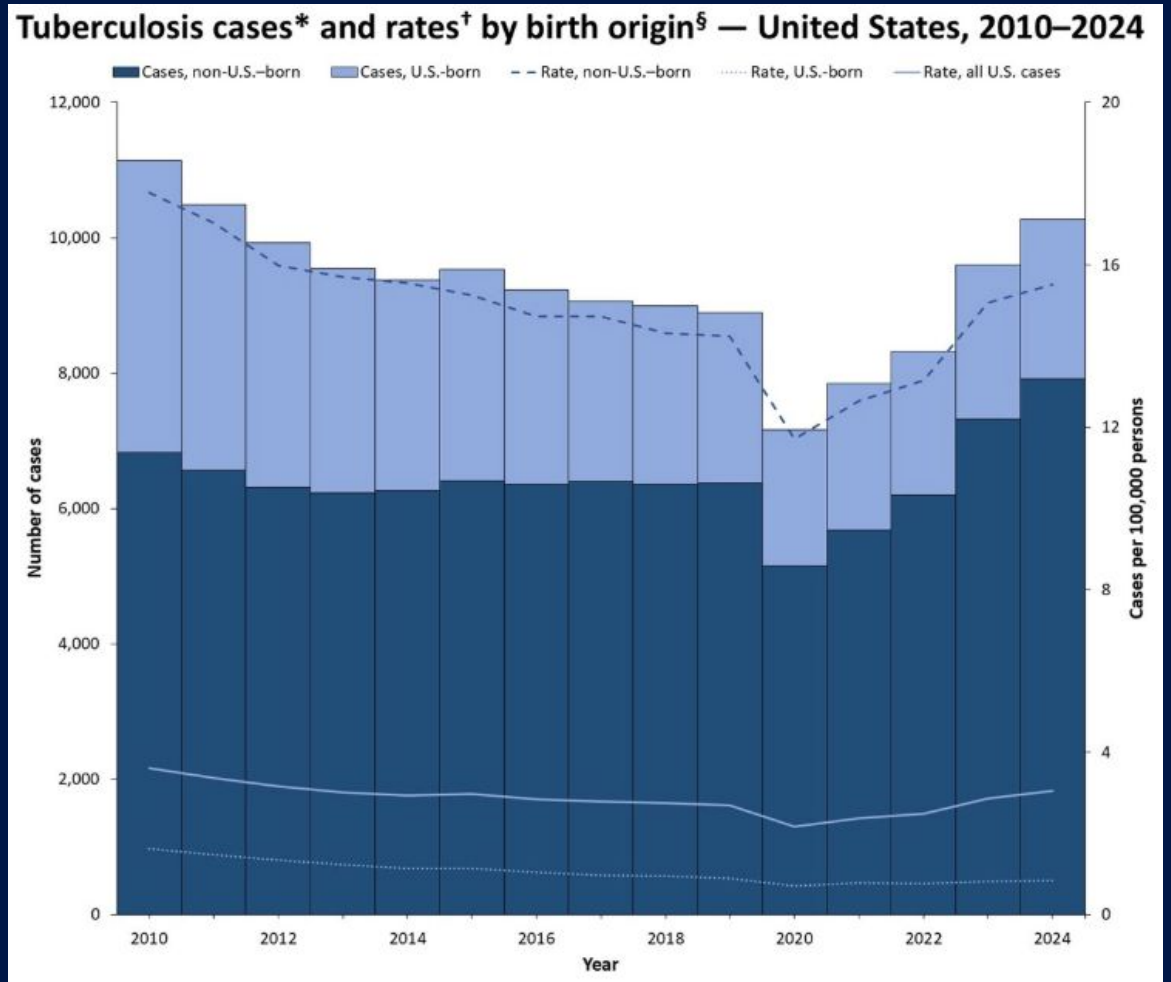
MSN

A US State Just Reported The Largest Tuberculosis Outbreak In American History

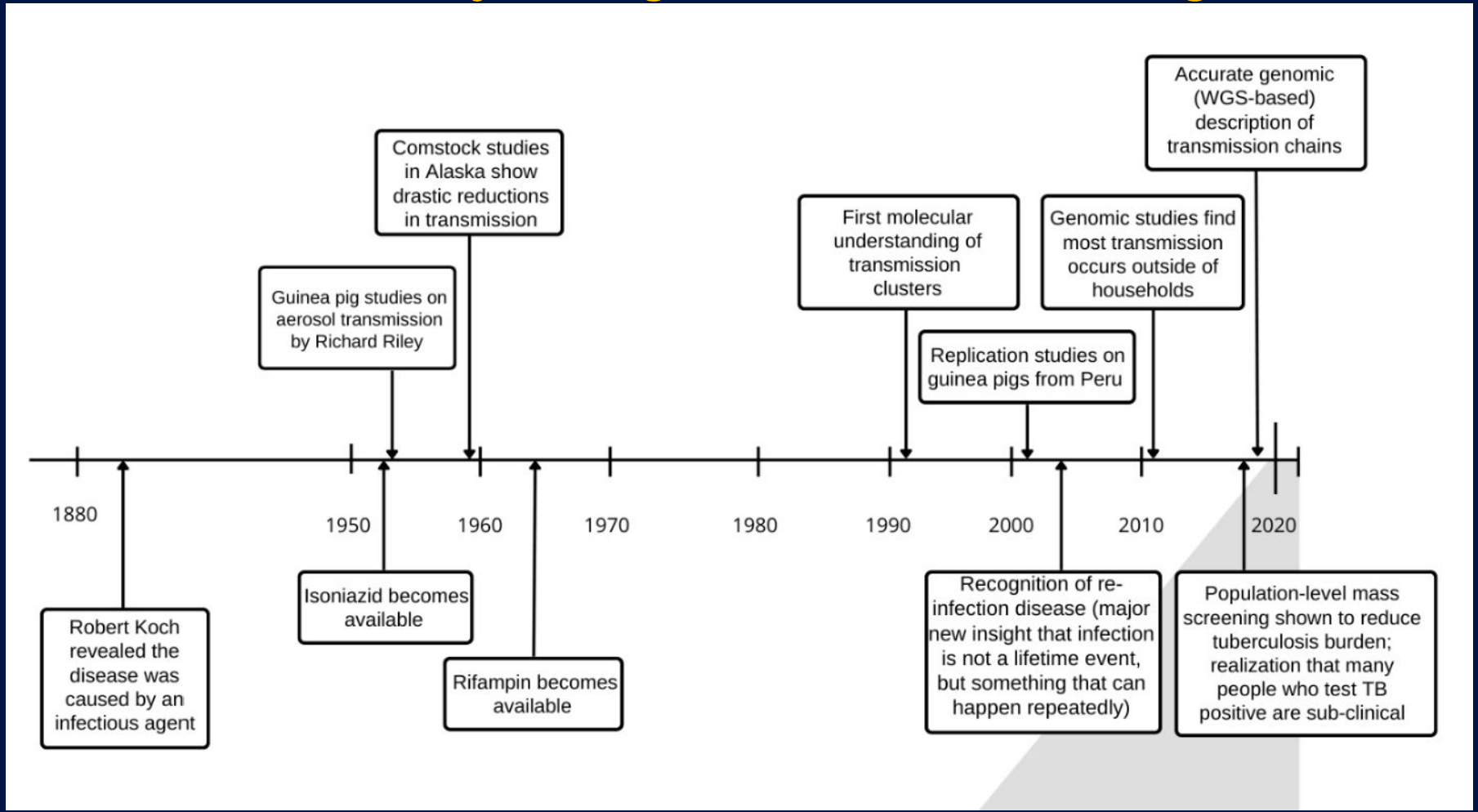
Two counties in Kansas are seeing an unprecedented number of tuberculosis cases with 67 active infections as of January 24, according to the Kansas...

8 hours ago

Epidemiology: *Why should you be interested in this topic?*

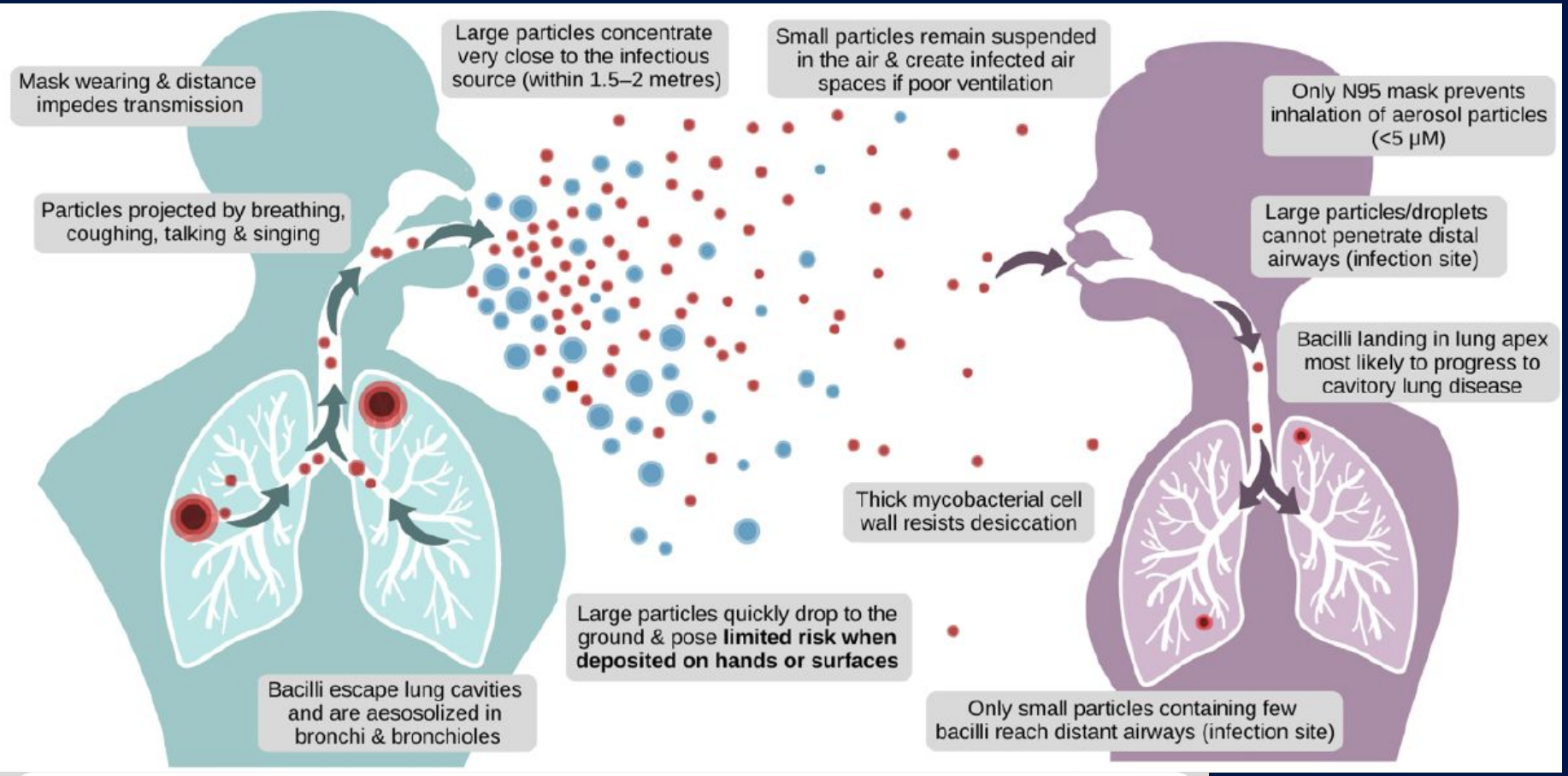


Timeline of major insights into understanding of TB



TB Transmission

TB Transmission: *How is TB transmitted?*



Coleman et al. *Pathogens*. 2022. 11:1228

TB Transmission:

What are clinical, microbial, environmental and host factors associated with increased risk of TB transmission?

Infectious Source

Ability to generate infectious aerosol

Bacillary load & tussive force

Potential asymptomatic transmission (singing, talking, breathing)

Social

Number and duration of close contacts

Time spend in poorly ventilated spaces

Re-aersolization after surface deposition (?)

Pathogen

Strain related variability; drug resistance

Viability/fitness/virulence of bacilli

Ability to withstand dessication / UV light exposure

Environment

Ventilation – air exchange cycles/hour

Air pollution – increased airway inflammation

UV light and humidity – viability of infectious particles

Susceptible Host

Risk of infection

Proximity and duration of contact with infectious source/ infected airspaces

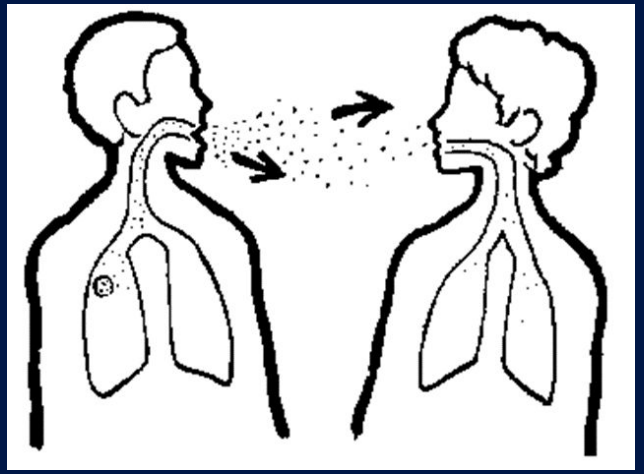
Risk of Disease

Systemic vulnerability – HIV/AIDS, young age (immune immaturity), other T-cell immune compromise

Lung vulnerability – structural lung damage & airway inflammation

Coleman et al. *Pathogens.* 2022. 11:1228

TB Transmission:
How is TB infectiousness defined?



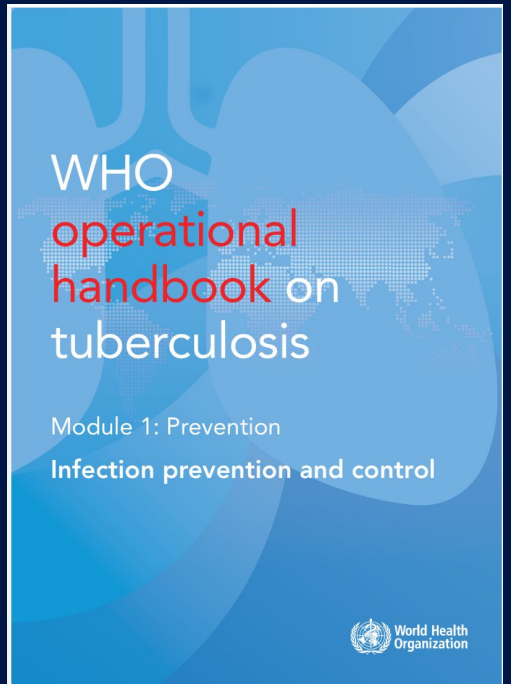
Infectiousness of person with tuberculosis (PWTB) is mainly dependent on 2 factors:

- **Bacterial burden**: Prior to *effective** Anti-Tuberculosis Treatment (ATT) initiation…
  - PWTB with **higher** respiratory bacterial burden (i.e., sputum smear- & PCR-positive; esp. if there's lung cavitation on chest imaging) may be considered as relatively more infectious than those with **lower** bacterial burden
    - * Effective ATT is defined as a recommended multidrug regimen to which the organism is susceptible or anticipated to be susceptible.
- **Treatment**: PWTB on less than 5 days of effective* ATT should be considered relatively more infectious than those on longer durations of effective* ATT

TB Transmission: *How is airborne M. tb transmission defined?*

Airborne *Mycobacterium tuberculosis* transmission:

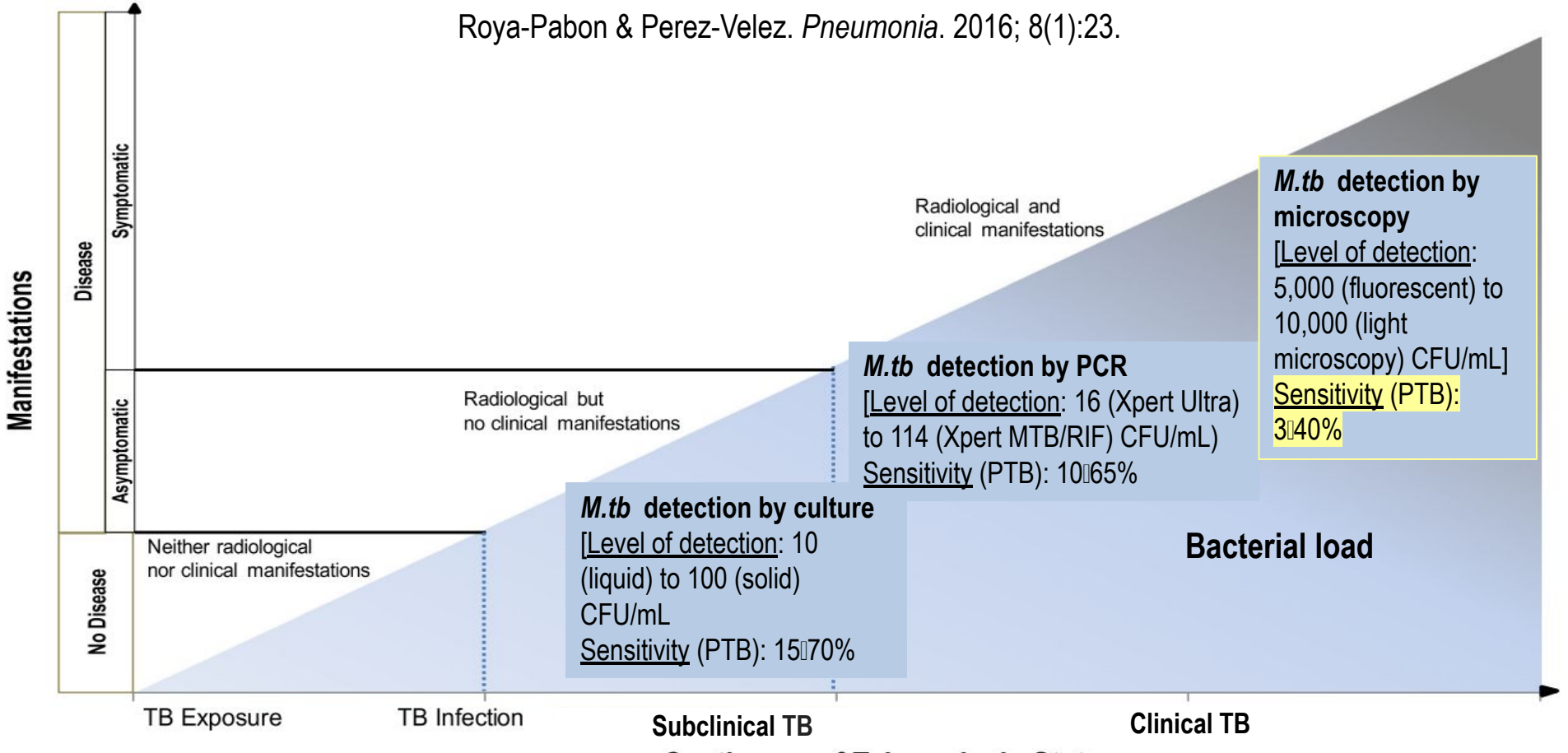
- Spread of aerosolized *M. tuberculosis*…
  caused by the dissemination of infectious respiratory particles…
  when suspended in air over long distances and time.



Coleman, M et al. *Pathogens* 11.11

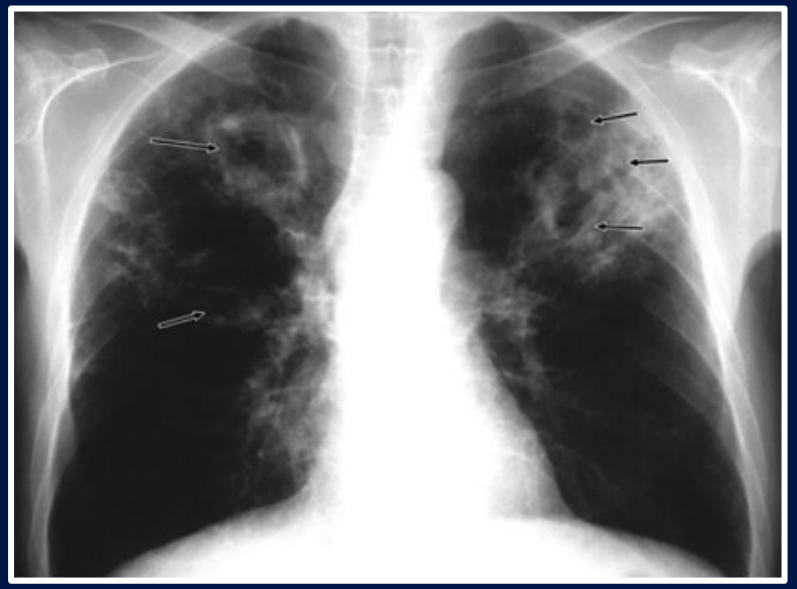
TB Transmission: Continuum of TB states and correlations with bacterial load/burden and with radiological and clinical manifestations

Roya-Pabon & Perez-Velez. *Pneumonia*. 2016; 8(1):23.



TB Transmission: *What factors are associated with **elevated** risk for TB transmission via droplet nuclei?*

- AFB smear microscopy-positive sputum (4+ > 3+ > 2+ > 1+ > trace)
- PCR-positive sputum
- Culture-positive sputum
  - Short time (<9 days) to detection of culture isolation of M. tb
- Laryngeal TB
- Cavitary pulmonary disease →



TB Transmission:

Can a patient with pulmonary TB, and with three negative results of AFB smear microscopy of adequate samples of sputum, still be infectious?

Yes, AFB smear-negative PTB still confers a substantial transmission risk.

- In a study that included >1500 patients with culture-positive TB, those with negative smears were responsible for about *17% of TB transmission*
  - [Behr et al. *Lancet*. 1999. 353:444].

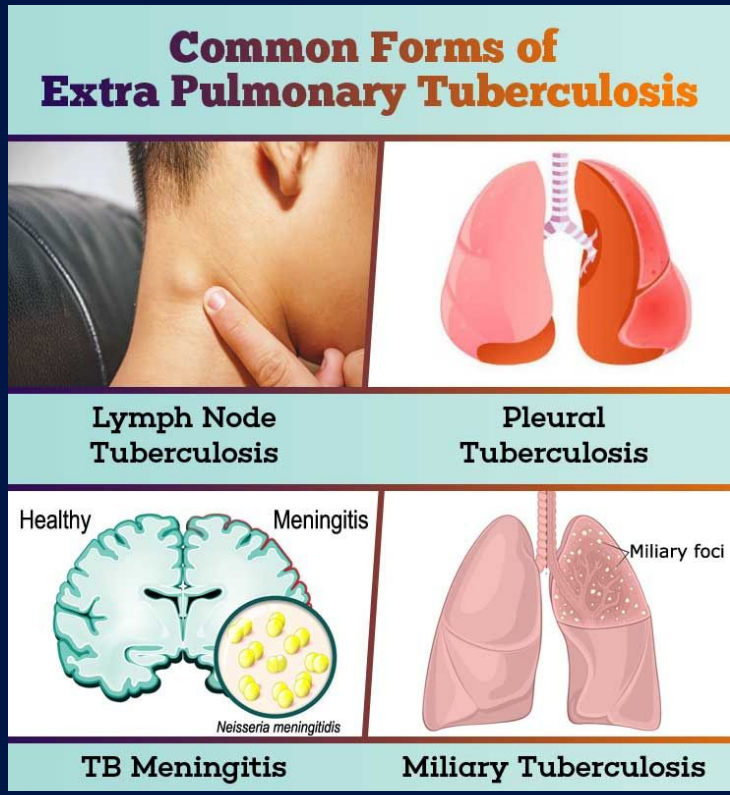
- The transmission risk of PCR-negative patients on TB treatment for less than 1 week appears to be lower than that of smear-negative patients (5% vs. 11% in one retrospective study from the USA, a low-incidence country), *but is not negligible*
  - [Xie et al. *Clinical Infectious Diseases*. 2018. 67:1653]

Are patients with extrapulmonary TB contagious?

- Patients with isolated extrapulmonary TB are not contagious; however, such patients require careful evaluation for presence of concurrent pulmonary or laryngeal TB.

- Concurrent pulmonary TB is common in patients with pleural or pericardial TB.

- Immunocompromised patients with extrapulmonary TB should be presumed to have pulmonary TB until proven otherwise with negative sputum samples for AFB smear and culture or NAA testing, even if chest radiography is normal.

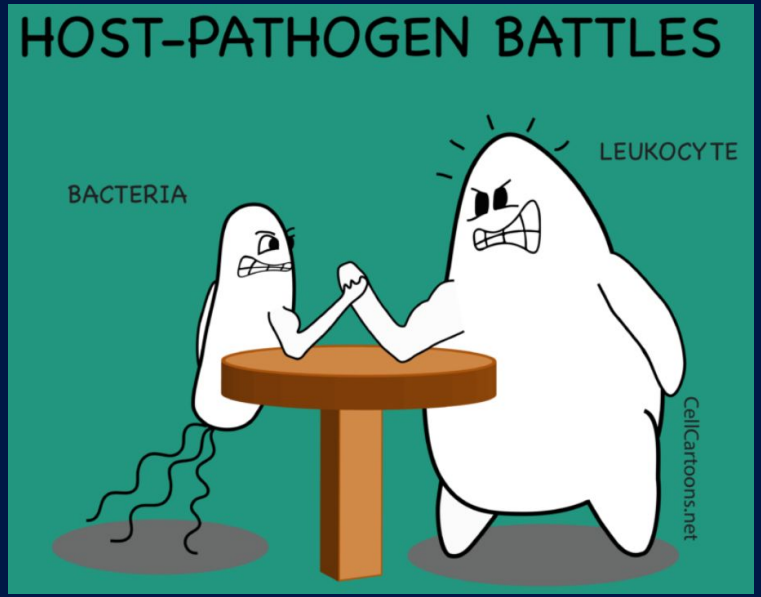


TB Health-care-related transmission:

Which procedures can result in the dispersal of droplet nuclei that are associated with the risk for TB transmission?

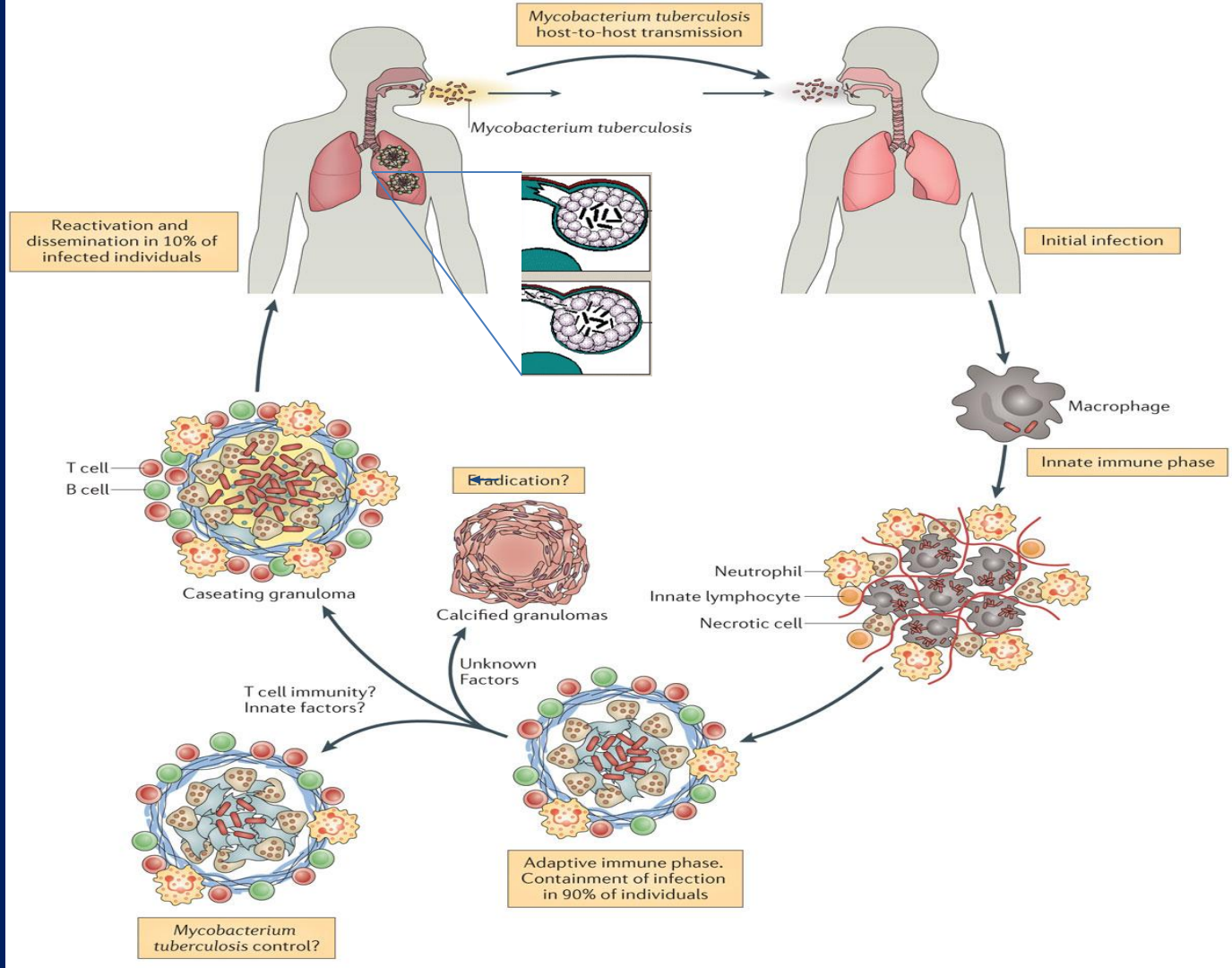
- Endotracheal intubation
- Bronchoscopy
- Sputum induction
- Chest physical therapy
- Administration of aerosolized drugs
- Irrigation of a tuberculous abscess
- Autopsy on a cadaver with

TB Life Cycle and Pathogenesis

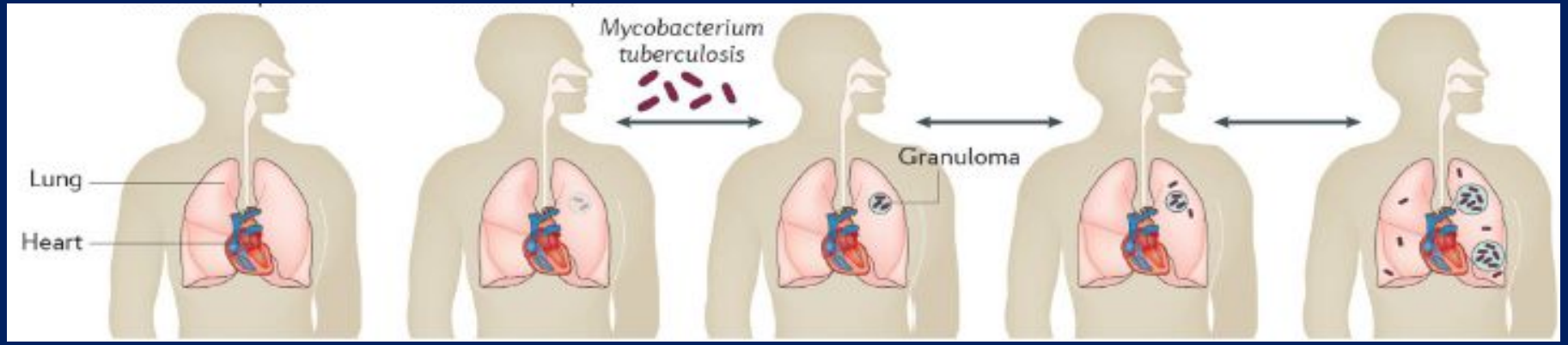


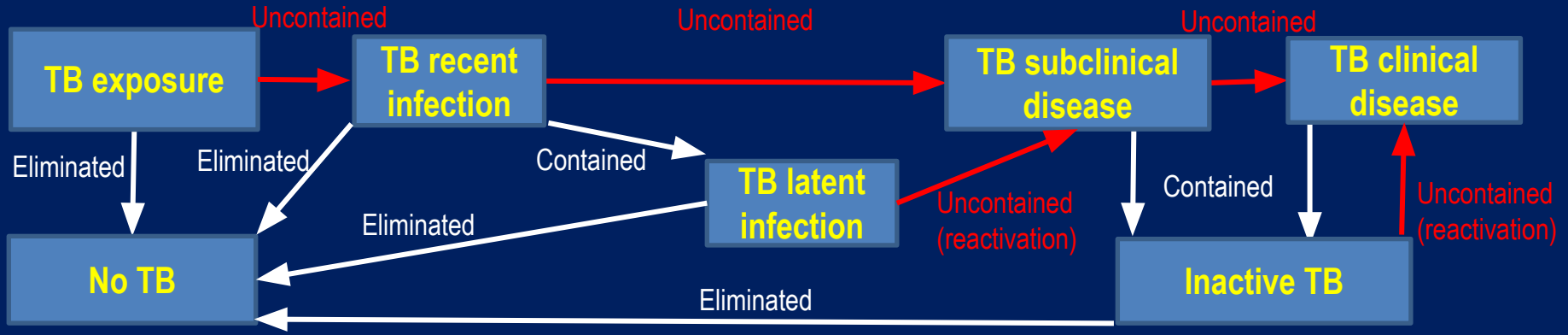
Mycobacterium tuberculosis

Life Cycle



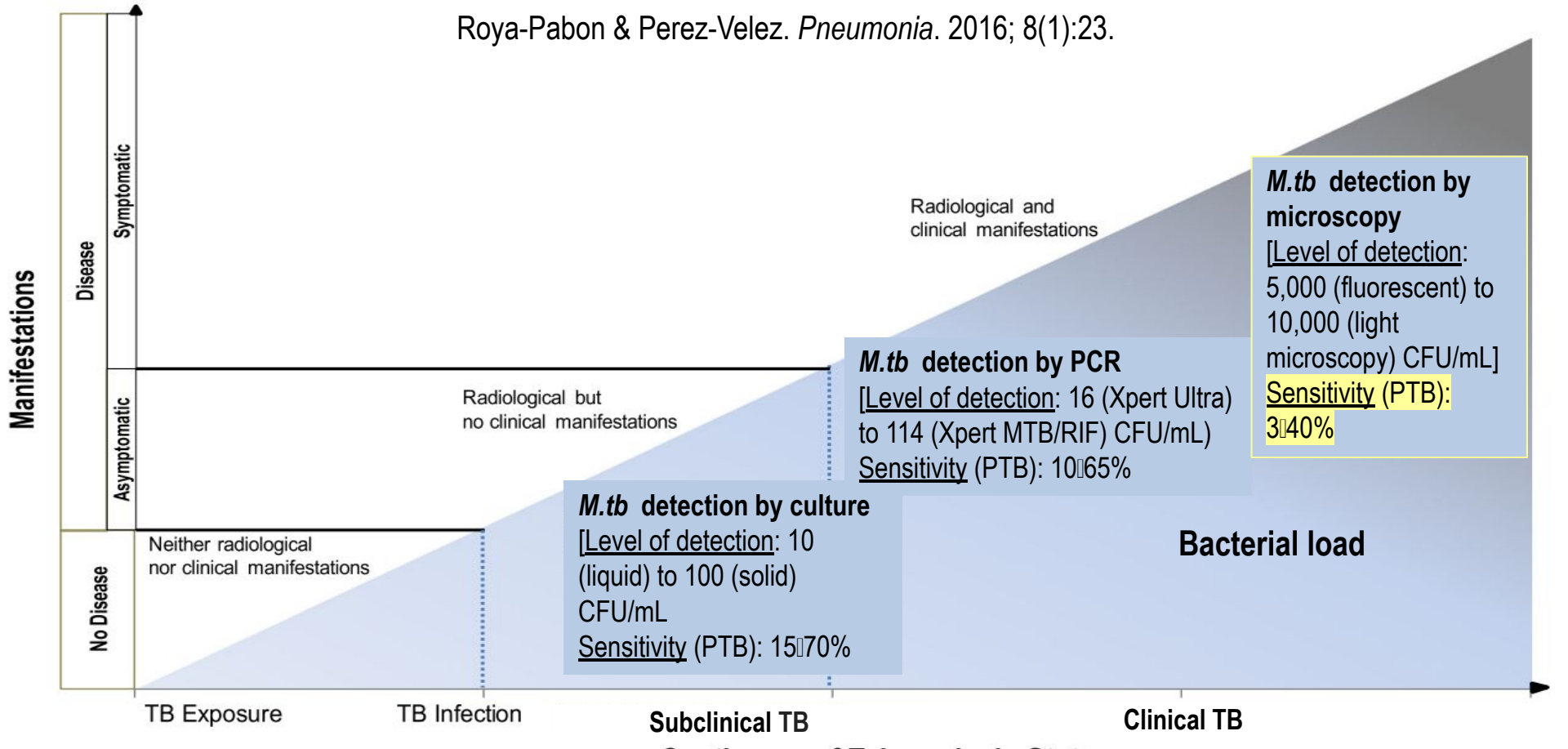
What is the continuum of TB states?





- International Consensus for Early TB Group. *Lancet Respiratory Medicine*. 2024. 12:484.
- Pai et al. *Nature Reviews Disease Primers*. 2016. 2:16076
- Drain et al. *Clinical Microbiology Reviews*. 2018. 31:e00021

Continuum of TB states and correlations with bacterial load and with radiological and clinical manifestations



Classification of TB States

Criteria	*Early* TB States				*Late* TB States		
	TB Exposure	TB Infection	Non-infectious Subclinical TB	Infectious Subclinical TB	Inactive TB	Non-infectious Clinical TB	Infectious Clinical TB
Epidemiologic risk	+	+	+	+	+	+	+
Immune-based test	–	+	+	+	+	+/–	–/+
Radiologic abnormality	–	–	+	+	+	+	+
Microbiological detection	–	–	–	+	–	–	+
Clinical Manifestations	–	–	–	–	–	+	+

- International Consensus for Early TB (ICE-TB) Group. “Classification of early tuberculosis states to guide research for improved care and prevention: an international Delphi consensus exercise.” *Lancet Respiratory Medicine*. 2024. 12:484.

Classification of intrathoracic TB based on continuum states and their immunopathogenesis

Continuum state	Immunological control	Immune-based tests	Bacterial replication	Chest imaging abnormalities (that may be present)	Clinical findings	Microbiologic studies	Antimycobacterial Treatment
TB Eliminated	Infection **eliminated by *innate* immunity**	**TST/IGRA Negative**	Not applicable	- **None**	None (asymptomatic)	Negative	Not indicated
	Infection **eliminated by *adaptive* immunity**	**TST/IGRA Positive**					
TB infection	Infection not eliminated but **controlled** by immune system	**TST/IGRA Positive** *(except in immunologic window)*	Bacteria **persisting in *non-replicating* state**	- None - Calcified non-enlarged regional lymph nodes - Calcified lung nodules - Pleural thickening (scarring)			1-2 meds x 1-9 mo.
Incipient TB	Infection ***not* controlled** by immune system	**Transcriptomic biosignatures** of host blood RNA molecules (eg, IFN response genes)	Bacteria **replicating but *undetectable***	- None			?
Subclinical TB disease		**TST/IGRA Usually positive**	Bacteria **replicating and potentially *detectable***	**Nonsevere abnormalities** - Uncomplicated hilar/mediastinal lymphadenopathies - Non-calcified lung nodules - Pleural effusion w/o severe underlying lung dis.		Rarely positive	If drug-susceptible: 4 meds x 2 mo. 2-3 meds x 2 mo.
Non-severe TB disease						Positive cultures of respiratory specimens in ~10-30% of cases	
Severe TB disease		**TST/IGRA Usually positive (but may be *initially neg.* in** immunocompromised patients, esp. w/ overwhelming disease)		Severe abnormalities - Bronchopneumonia - Multilobar pneumonia - Lung parenchymal cavities - Pleural empyema - Pericardial effusion - Diffuse micronodules (miliary TB)	Present	Positive cultures of respiratory specimens in ~30-70% of cases	If drug-susceptible: 4 meds x 2 mo. 2 meds x 4 mo.

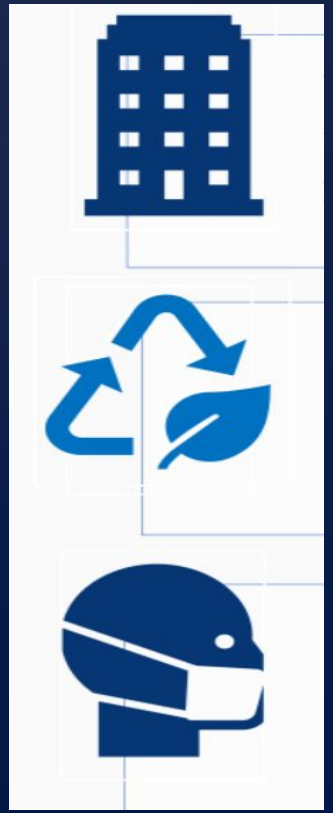
Perez-Velez CM. “Diagnosis of Intrathoracic Tuberculosis.” In: *Handbook of Child & Adolescent Tuberculosis*. 2016.

Infection Prevention & Control of Tuberculosis (TB-IPC): **General**

Infection Control Plan for Tuberculosis

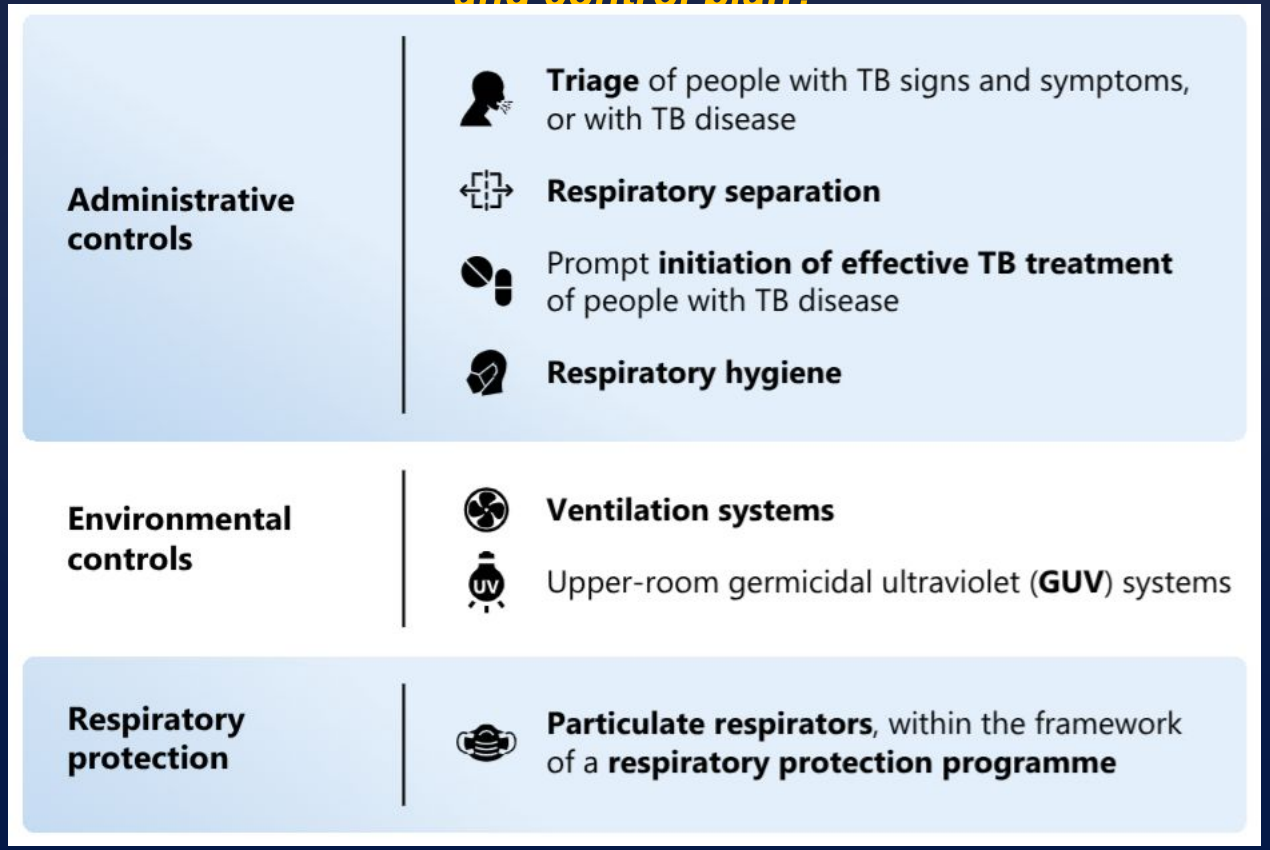
- Hospital-based infection control programs are critical for limiting nosocomial transmission of TB.

- Important measures for a successful program to prevent & control TB include:
  - designating responsibility for TB control
  - having a written infection prevention and control plan



Infection Control Plan:

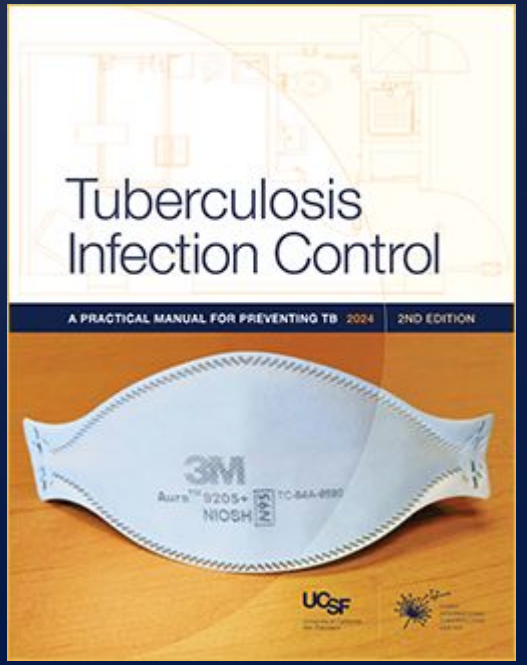
What is the hierarchy of a TB-specific infection prevention and control plan?



Infection Prevention & Control of Tuberculosis (TB-IPC): **Administrative Controls**

Administrative Controls

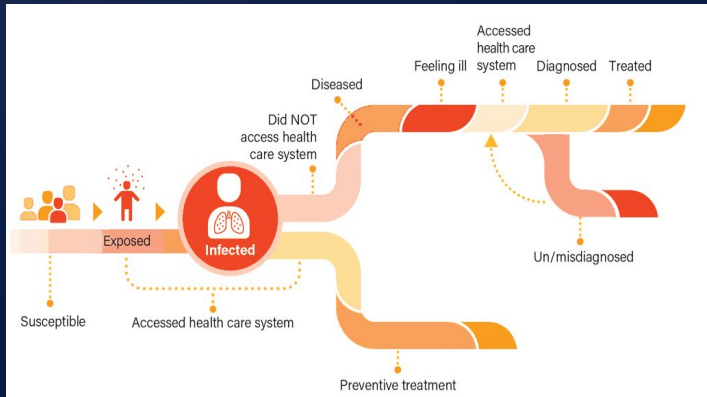
- Definition: Organizational policies and procedures to minimize the risk of transmission of TB
- The FAST (**F**ind cases **A**ctively, **S**eparate safely, **T**reat effectively) strategy: IPC strategy for TB that focuses on implementing and monitoring administrative processes & procedures to reduce TB transmission, especially in health-care settings, emphasizing:
  - Rapid diagnosis
  - Safe separation
  - Effective treatment



TB-IPC: Clinical Approach

What are the steps to approaching a patient with suspected pulmonary TB from the IPC perspective?

- **Step 1**: Assessing risk for TB to allow for early detection of suspect cases
- **Step 2**: Timely diagnostic evaluation of suspect cases
- **Step 3**: Clinical triaging of suspect PTB cases to reduce potential transmission
- **Step 4**: Respiratory isolation precautions of suspect cases
- **Step 5**: Source control measures of suspect cases
- **Step 6**: Prompt initiation of curative treatment of cases (presumptive or confirmed)
- **Step 7**: Contact investigation ASAP
- **Step 8**: Post-exposure prophylaxis and preventative treatment
- **Step 9**: Education and training of health-care personnel
- **Step 10**: Coordination with public health TB Control Program
- **Step 11**: Assessing compliance with the TB control plan
- **Step 12**: Surveillance



Source: Roadmap towards ending TB in children and adolescents. Geneva: World Health Organization; 2018 (https://apps.who.int/iris/handle/10665/275422).

Step 1: Assessing risk for TB to allow for early detection of suspect cases:

How to identify individuals with active TB disease sooner than later?

- **Active case-finding (ACF)**: Actively searching for TB in high-risk groups using screenings to identify cases early.
- **Cough surveillance**: Implementing effective cough surveillance in health-care facilities, by using a structured approach:

Step 1: Assessing risk for TB to allow for early detection of suspect cases:

How to identify individuals with active TB disease sooner than later?

Active case-finding: In a person with risk factors for having acquired TB infection, active pulmonary TB disease should be suspected in the following circumstances:

- Cough of ≥2 weeks' duration, particularly when accompanied by one or more of the following: fever, night sweats, weight loss, and hemoptysis
- Unexplained cough and fever (of any duration) in the context of HIV infection
- Community-acquired pneumonia that has not improved after 5 days of Tx in the setting of increased risk for TB
- Incidental findings on chest imaging suggestive of TB in the setting of increased risk for TB, even in the absence of symptoms (i.e., subclinical [asymptomatic] TB)

TB-IPC: Clinical Approach

Step 1: Assessing risk for TB to allow for early detection of suspect cases: *How to identify individuals with active TB disease sooner than later?*

Cough surveillance: Implementing effective cough surveillance in health-care facilities,by using a structured approach:

- Standardized screening (WHO Symptom Checklist: *"Have you been coughing for 2 weeks or more?"*)
- Training HCWs: To recognize possible TB symptoms, to ask screening questions
- Efficient diagnostics: Immediate referral for:
  - *M.tb* PCR (e.g., GeneXpert MTB/RIF)
  - Chest radiography

TB-IPC: Clinical Approach

Step 1: Assessing risk for TB to allow for early detection of suspect cases: *What are risk factors for acquiring TB infection?*

- Recent exposure to a person with a case of infectious TB
- History of a positive test result for *M. tuberculosis* infection
- Substance use disorder
- Birth in or travel to a region where TB incidence is high
- Residents and employees of high TB-risk congregate settings such as homeless shelters and prisons, based on local epidemiology
- Residing in a medically underserved and/or low-income population with high rates of TB

Step 1: Assessing risk for TB to allow for early detection of suspect cases:

What are risk factors for acquiring TB infection?

Risk factor	Estimated risk relative to persons with no known risk factor
AIDS	110–170
HIV infection	50–110
Immunosuppressant therapy for transplantation	20–74
Silicosis	30
Chronic renal failure requiring hemodialysis	10–25
Carcinoma of head and neck	16.0
Recent tuberculosis (TB) infection (≤2 years)	15.0
TNF-alpha inhibitors (Infliximab; Adalimumab; Etanercept)	1.7–9
Prolonged glucocorticoids (prednisone ≥ 15 mg or equivalent per day)	7.7
Prolonged glucocorticoids (prednisone < 15 mg or equivalent per day)	2.8
Immunosenescence (elderly ≥ 65 years of age)	2–10
Diabetes mellitus (all types)	2–3.6
Immunological immaturity (children ≤ 4 years of age)	2.2–5
Cigarette smoking (≥ 1 pack/day)	2–3

Step 2: Timely and rapid diagnostic evaluation of suspect cases

- **Definition**: Use of rapid diagnostic tools (e.g., Xpert MTB/RIF) to quickly identify TB cases and drug resistance.
- **Location**: Diagnostic evaluation for TB may be performed in the outpatient or inpatient setting [2,28].
- **Approach**
  - **Interview** patient (and family members, spouses, caregivers, or close friends) to screen for:
    - Symptoms that can be attributable to TB disease
    - Risk factors for acquiring TB infection
    - Risk factors for TB infection to progress to TB disease
  - **Clinical examination** (vital signs, anthropometry; physical exam)
  - **Chest imaging studies** (e.g., radiography; CT)
  - **TB immune-based testing** (e.g., T-SPOT.TB; QuantiFERON.TB Gold; PPD-Tuberculin Skin Test)
  - **Microbiological testing**: Samples of respiratory specimen(s) for (1) PCR; (2) Culture; (3) AFB smear microscopy
    - Sputum collection: A series of at least 3 high-quality sputum specimens should be collected in 8- to 24-hour intervals (*with at least one specimen obtained in the early morning*).
      - Sputum induction: If/When the patient is unable to spontaneously produce an adequate sputum sample (Target vol. 10 mL; Minimum vol. 5 mL)
    - Broncho-Alveolar Lavage (BAL): If/When the patient is unable to produce an adequate sputum sample despite two consecutive days, of two back-to-back sputum induction procedures per day
      - Clinical Pearl: If/When BAL is carried out, collect spontaneous sputum afterwards!

Step 3: Clinical triaging of suspect PTB cases to reduce potential transmission:

What's this?

Definition: Identification of patients with suspected, presumptive, or confirmed PTB, followed by *prompt* and safe separation to reduce *M. tb* transmission

- to HCWs and other employees
- to other patients
- to visitors
- to vulnerable populations in the community and household.

Step 3: Clinical triaging of suspect PTB cases to reduce potential transmission:

What are indications for hospitalization?

- **Clinical Indications**
  - Severe pleuropulmonary involvement: Hemoptysis; dyspnea; pleuritic chest pain
  - Neurological involvement: Meningitis or brain abscess.
  - Cardiac involvement: Pericarditis or myocarditis.
  - Severe malnutrition: Requiring nutritional support and monitoring.
  - Severe liver disease: Requiring specialized care and monitoring of liver-taxing medications

- **Social and Environmental Indications**
  - Homelessness: Lack access to safe housing, food, and sanitation.
  - Inadequate living conditions: Living in crowded or unsanitary conditions (increasing the risk of transmission)
  - Non-adherence to treatment: Patients who are unlikely to adhere to Tx
  - Lack of social support: Patients without a support system to ensure proper care and Tx

- **Public Health Indications**
  - Drug-resistant TB: Patients with suspected or confirmed DR-TB, requiring specialized care and isolation.
  - TB in pregnant or postpartum women: Requiring specialized care and monitoring.
  - TB in young children: Children under 5 years old with TB, requiring specialized care and monitoring.

Step 3: Clinical triaging of suspect PTB cases to reduce potential transmission:

When should A.I.I. precautions be initiated?

Initiate A.I.I. precautions in all of the following:

- **Suspected** (a.k.a., possible) pulmonary TB
- **Presumptive** (a.k.a., clinically-diagnosed; bacteriologically-negative; probable) PTB
- Bacteriologically-**confirmed** pulmonary TB

Step 3: Clinical triaging of suspect PTB cases to reduce potential transmission:

When should A.I.I. precautions be discontinued

in a patient with suspected (i.e., not yet confirmed or excluded) PTB who is in the community or in a health-care facility?

A.I.I. precautions may be discontinued when PTB is deemed clinically unlikely and one or more of the following are met:

- An alternative diagnosis accounting completely for the clinical syndrome has been established.
- Results of AFB smear microscopy of 3 consecutive sputum samples (2-5 mL) are negative.
- Results of PCR (specifically Xpert MTB/RIF) testing of 2 consecutive sputum samples are negative.
    - Xpert MTB/RIF detects 95-100% of smear-positive cases [FDA and CDC. *MMWR*. 2015. **64**:193].

Note: Mycobacterial culture of 3 sputum samples is still warranted in such cases, for the following reasons:

- To maximize diagnostic sensitivity (culture is more sensitive than PCR testing, including Xpert MTB/RIF)
    - Xpert MTB/RIF detects only 50-70% of smear-neg., culture-pos. cases [FDA & CDC. *MMWR*. 2015. **64**:193].
    - Therefore, clinical judgment remains paramount, even with negative Xpert MTB/RIF results.
- To perform phenotypic drug susceptibility testing
- To diagnose non-tuberculous mycobacterial infection

Reference: National Tuberculosis Controllers Association and Association of Public Health Laboratories. *Consensus statement on the use of Cepheid Xpert MTB/RIF assay in making decisions to discontinue airborne infection isolation in healthcare settings*. 2016.

Sputum sampling for mycobacterial testing:

What is the recommended volume of sputum for each mycobacterial test?

- Sputum quantity and quality is critical to the performance of these mycobacterial tests

Mycobacterial Test	Target Volume *(for optimal accuracy)*	Minimum Volume *(per APHL & WHO)*
M.tb **PCR (or NAAT)**	2 mL	1 mL
Mycobacterial culture	4 mL	2 mL
AFB Smear Microscopy	4 mL	2 mL
Total Volume	10 mL	5 mL

- ***Negative*** predictive value of Xpert MTB/RIF: Negative Xpert MTB/RIF results from 1 or 2 sputum specimens are highly predictive of the results of 2 or 3 **negative** AFB-smear-microscopies
- ***Positive*** predictive value of Xpert MTB/RIF: When compared with the results of 2 or 3 serial fluorescence-stained AFB-smears…
  - One Xpert MTB/RIF result detected ~97% of patients who were smear-**positive** and culture-confirmed TB cases
  - Two serial Xpert MTB/RIF results detected 100% of smear-positive, mycobacterial-culture-positive TB cases

References

- Association of Public Health Laboratories (APHL). *Guidelines for Submission of Sputum Specimens for Tuberculosis Testing*. 2018.
- World Health Organization. "Standard operating procedures for sample collection methods." *W.H.O. TB Knowledge Sharing Platform*.
- Luetkemeyer et al. *Clinical Infectious Diseases*. 2016. **62**:1081.

Step 3: Clinical triaging of suspect PTB cases to reduce potential transmission:

When should A.I.I. precautions be discontinued in a patient with presumptive or confirmed PTB who is in the community (e.g., at home) — Not in a health-care facility?

- **Available evidence**: While there is individual variability in infectiousness, most PWTB are non-infectious (i.e., unlikely to transmit to others) after the first 24–72 hours of ATT initiation.
- **Recommendation**: Community-based respiratory isolation & restrictions (RIR) after 5 days of effective ATT if the following have been met:
  - Therapeutic response to ATT (i.e., improvement — not necessarily complete resolution — of Sx)
  - ATT adherence (i.e., 100%)
  - ATT tolerance (i.e., no significant side effects)
  - Conducting a public health evaluation (e.g., children <5 y.o., immunocompromised)
- **Notes**:
  - This is regardless of sputum bacteriologic status during ongoing ATT (ie, PCR, Smear, Culture)
  - Unjustified longer durations of RIR may potentially result in increased patient harms (including effects on employment, education, food and housing security, and mental health due to fears of transmission, stigma, and social isolation)
  - Expert consultation should be sought when RIR has extended beyond 14 days.

Reference: Shah et al; NTCA. *Clinical Infectious Diseases*. 2024. ciae199.

Step 3: Clinical triaging of suspect PTB cases to reduce potential transmission:

*When should A.I.I. precautions be discontinued in a patient with confirmed PTB who is in a **health-care facility**?*

For PWTB in a health-care facility, A.I.I. precautions may be discontinued when the following criteria have been attained:

- ATT has been administered for at least 14 days
- ATT is deemed to be effective based on confirmed drug-susceptibility testing results (or is anticipated to be susceptible)
- Therapeutic response to ATT (i.e., improvement — not necessarily complete resolution — of symptoms)
  - Cough frequency is reduced after 2 weeks of appropriate ATT — which considerably diminishes the potential for airborne transmission
- ATT adherence (i.e., 100%)
- ATT tolerance (i.e., no significant side effects)
- *Three subsequent negative sputum AFB smears (evidence-based ???)*

Step 4: Respiratory isolation precautions of suspect cases

Patients with suspected/confirmed TB should be placed in respiratory separation (isolation) to prevent TB transmission until deemed non-infectious

- **Health-care setting**: Immediately placement in Airborne Infection Isolation (A.I.I.) room
  - Procedures should be performed in A.I.I. room to minimize M.tb transmission to others who enter the room.
- **Community setting**: Respiratory isolation and restrictions (RIR)
  - **Isolation Measures**
    - Home Isolation: Avoiding contact with individuals outside their household; Minimizing time spent in common areas
    - Respiratory Precautions: Wear a well-fitting surgical face-mask whenever they are around others; Cough etiquette
    - Airborne Precautions: Well-ventilated room, ideally with windows open to promote air exchange; Avoid using air conditioning systems that could circulate air to other parts of home.
  - **Activity Restrictions**
    - Avoiding Public Places and Gatherings: No work, school, or public transportation use; Avoid close contact with immunocompromised individuals (e.g., elderly; young children; PLHIV).
    - Household Member Precautions: Avoid prolonged, close, indoor exposure to patient

Step 5: Source control measures of suspect cases:

What practices can be implemented to reduce the release of infectious droplet nuclei from the source patient?

- Respiratory hygiene in people with presumptive or confirmed TB is recommended to reduce *M. tb* transmission to others (household members, HCWs) -- especially immunocompromised persons.

- Patients should be:
  - Educated about the purpose of the isolation room
  - Instructed in cough etiquette (cover nose and mouth when coughing or sneezing with face-mask, tissues, or shirt sleeve)
    - Even while in the isolation room
  - Instructing the patient to wear a surgical face-mask, especially when outside the A.I.I. room.

Step 6: Curative treatment of cases (clinically diagnosed or bacteriologically confirmed)

Prompt initiation of *effective* TB **treatment** of people with TB disease is recommended to reduce *M. tb* transmission to HCWs and visitors.

- **Effective treatment**: Effective TB treatment is essential to stop the spread of TB
  - Initially guided by results of rapid genotypic drug-resistance testing (e.g., GeneXpert MTB/RIF)
  - Later adjusted by results of phenotypic drug-susceptibility testing after culture isolation
- **Prompt treatment**: Starting effective TB treatment as soon as diagnosis of presumptive or confirmed TB is made

Step 7: Contact investigation

- **Purpose**: To identify secondary cases of active and latent TB or, in some situations, a source case.
- **Performed by who**: In collaboration with public health officials of TB Control Program.
- **Criteria for initiation**: Confirmed *or presumptive* infectious cases

Reference: NTCA and CDC. "Guidelines for the investigation of contacts of persons with infectious tuberculosis. Recommendations from the National Tuberculosis Controllers Association and CDC." *MMWR Recommendations and Reports*. 2005. 54(RR-15):1

Step 7: Contact investigation

- **Performed on who**: *Close contacts*, including household members; Coworkers

- **Definition of a close contact**: A person who shared air-space with the index patient an enclosed/indoor space (e.g., household, social gathering place, workplace or facility)
  - for > 8-15 hours per week or >40-180 hours total
  - during an infectious period

- **When is the infectious/contagious period considered to have begun**:
  - AFB-smear-positive PTB: 3 months prior to the first smear-positive sputum or three months prior to the onset of symptoms — *whichever is earlier*.
  - AFB smear-negative PTB: 1 month prior to onset of symptoms.

Reference: NTCA and CDC. "Guidelines for the investigation of contacts of persons with infectious tuberculosis. Recommendations from the National Tuberculosis Controllers Association and CDC." *MMWR Recommendations and Reports*. 2005. 54(RR-15):1

Step 7: Contact investigation:

When is a contact investigation, within a health-care facility, warranted?

- If a patient with infectious PTB received care prior to institution of infection control measures.
- If a HCW is newly diagnosed with active, potentially infectious TB and may have exposed others while working prior to diagnosis.
- Identification of nosocomial TB transmission should prompt review of institutional TB control policy and practices.

Reference: NTCA and CDC. “Guidelines for the investigation of contacts of persons with infectious tuberculosis. Recommendations from the National Tuberculosis Controllers Association and CDC.” *MMWR Recommendations and Reports*. 2005. 54(RR-15):1

Step 7: Contact investigation:
What does the screening evaluation consist of?

- **Symptom screening**
- **TB immune-based testing**
  - Interferon-gamma release assay (IGRA) -- e.g., T-SPOT.TB or QuantiFERON-TB Gold
    PPD-Tuberculin Skin Test
  - **Notes**:
    - If there is documentation of a **previous**ly **positive** TB immune-based test, may not be helpful to repeat one
    - If result of initial TB immune-based testing is negative, it should be repeated 8 weeks following the end of the exposure.
- **Chest radiography**: Performed for contacts with positive results of TB immune-based testing

Reference: W.H.O. *Operational Handbook on Tuberculosis. Module 2: Screening - Systematic Screening for Tuberculosis Disease*. Geneva: W.H.O.; 2021

Step 7: Contact investigation:

What is the risk of a close contact progressing to active TB disease?

- In one study (carried out in the USA and Canada) that included more than 4400 contacts of patients with culture-confirmed PTB…
  - Risk over the course of five years: 4%
  - Of those who progressed to disease, how many within 3 months of the index patient's diagnosis: 75%

Reference: Reichler et al. *The Journal of Infectious Diseases*. 2018. 218:1000.

Age	Risk of progression from TB infection to TB disease if untreated
<12 months	40 to 50%
1 to 2 years	25%
>2 to 12 years	5 to 10%
>12 to 18 years	10 to 15%
>18 years	5 to 10%

Step 8: Preventative Therapy:

What is the role of post-exposure prophylaxis (PEP) for close contacts of infectious PTB patients with a negative TB immune-based test (IGRA or TST)?

Role: To prevent a recently-acquired TB infection (with a false-negative test result due to immunological window period or to immunocompromised state) from progressing to active TB disease while awaiting repeat testing 8 weeks later.

Indications

- Young children (<5 years old) due to their immature immune system
- Immunocompromised individuals (e.g., HIV infection, solid organ transplant recipients, immunosuppressive therapy)
- Highly exposed close contacts with high-risk exposure
- Recent close contact within the past 8–10 weeks

Effectiveness: ~90% effectiveness in preventing TB disease if the individual is truly infected.

Medication: Isoniazid or Rifampin (or Levofloxacin if MDR-TB exposure)

Duration

- If the repeat test, at 8 weeks after close contact's last exposure, is still negative and the individual remains asymptomatic, PEP may be discontinued.
- If the repeat test converts to positive, then complete duration of treatment for TB infection.

Step 8: Preventative Therapy:

What is the role of preventative treatment for close contacts of infectious PTB patients with a positive TB immune-based test (IGRA or TST)?

Role: to eliminate *Mycobacterium tuberculosis* before it can cause active disease.

Indications: Close contact with the following:

- positive result of a TB immune-based test
  - IGRA (e.g., QuantiFERON-TB Gold, T-SPOT.TB) positive
  - PPD-TST ≥5 mm induration
- No clinical or radiological findings suggestive of active TB disease
- Risk factors for progression of TB infection to TB disease:
  - Infants, young children (<5 years old)
  - Immunocompromised individuals (e.g., HIV, diabetes, cancer, organ transplant, TNF-alpha inhibitors)
  - Those with recent TB exposure (within the past 2 years)

Effectiveness: ~90%

Regimens:

- Isoniazid for 6–9 months
- Rifampin for 4 months
- Isoniazid + Rifapentine for 3 months, once-weekly

Step 9: Education and training health-care personnel

- Health-care personnel (HCP) should be trained in effective use of respiratory protection -- *especially those who care for patients with respiratory illness in facilities that care for patients who have, or who are at risk for, TB*.

- HCP in general should receive comprehensive education and training in:
  - TB clinical manifestations
  - TB transmission and infectiousness
  - TB prevention and control practices

Truth: Multiple studies have revealed that there are HCP (physicians; nurses, respiratory therapists) who do not understand that the combined protective effects of: (a) AII room (negative pressure, ≥12 ACH), (b) of properly fitted N95 respirator (≥95% filtration), and, (c) of limited duration of aerosol-generated procedures, is an estimated risk of TB infection per single AGP exposure of **<1% (and probably close to zero)**.

Consequence: There are HCP who avoid participating in the care of patients with suspected pulmonary TB

Step 10: Coordination with Public Health:

What are the components of the discharge planning of a PWTB?

Presumptive or confirmed cases of TB should be reported promptly to the TB Control Program of the local/state public health department to:

- Expedite contact investigation
- Assure adequate supply of medication is provided (not just the prescriptions) to last until the outpatient appointment
- Initiate case management with Directly-observed Therapy (D.O.T.) arranged through the TB Clinic
- Plan outpatient follow-up with a TB Clinic (provider and nurse with expertise in TB management

Step 11: Assessing compliance with the TB control plan

- Several studies have assessed the compliance with TB control plans for health-care facilities
  - They demonstrated the need for regular monitoring and evaluation of the implementation of the TB Control Plan in order to identify and correct lapses and thereby ensure its effectiveness.
- One prospective study, from two institutions which had experienced outbreaks of multidrug-resistant (MDR) TB, found that over a 2-year period…
  - Patients with PTB were not isolated on their first hospital day: 19%
  - Patients placed on TB isolation precautions who proved to have TB: 8%
  - Individuals entering A.I.I. rooms who did not wear masks: 4% of cases
  - Individuals who wore masks rather than respirators (even though they were available): ~50%

  Reference: Tokars et al. *Infection Control and Hospital Epidemiology*. 2001. 22:449
- In another report including 3 institutions, patients determined to be at risk for active TB disease were:
  - Placed in rooms that were not designed for negative pressure: 19% of cases
  - Placed in A.I.I. rooms although negative pressure was not activated or functional: 11% of cases

  Reference: Sutton et al. *Infection Control and Hospital Epidemiology*. 2000. 21:28

Step 12: Surveillance

- Surveillance (in collaboration with public health department) should include:
  - Analyses of TB incidence and affected groups in the community
  - Tabulation of cases over at least the previous 5 years in order to develop risk profiles for specific patient populations
  - Drug susceptibility data for TB cases should be reviewed
- Clues suggestive of potential patient-to-patient transmission include:
  - High proportion of cases with prior hospitalizations in the previous year
  - Sudden increase in cases (especially MDR-TB)
  - Multiple TB patients with identical drug-susceptibility patterns or DNA genotype
  - Increase in TST or IGRA conversion

TB-IPC: Environmental Controls

Environmental controls:

What are environmental controls for preventing the transmission of TB?

- **Definition**: Measures focusing on preventing the spread and reducing the concentration of infectious droplet nuclei in the air.
- **Components**
  - Airborne Infection Isolation (A.I.I.) room
  - Ventilation systems
  - Ultraviolet Germicidal Irradiation (UVGI)

Environmental controls: Airborne Infection Isolation (A.I.I.) room

Who should be placed in an A.I.I. room?

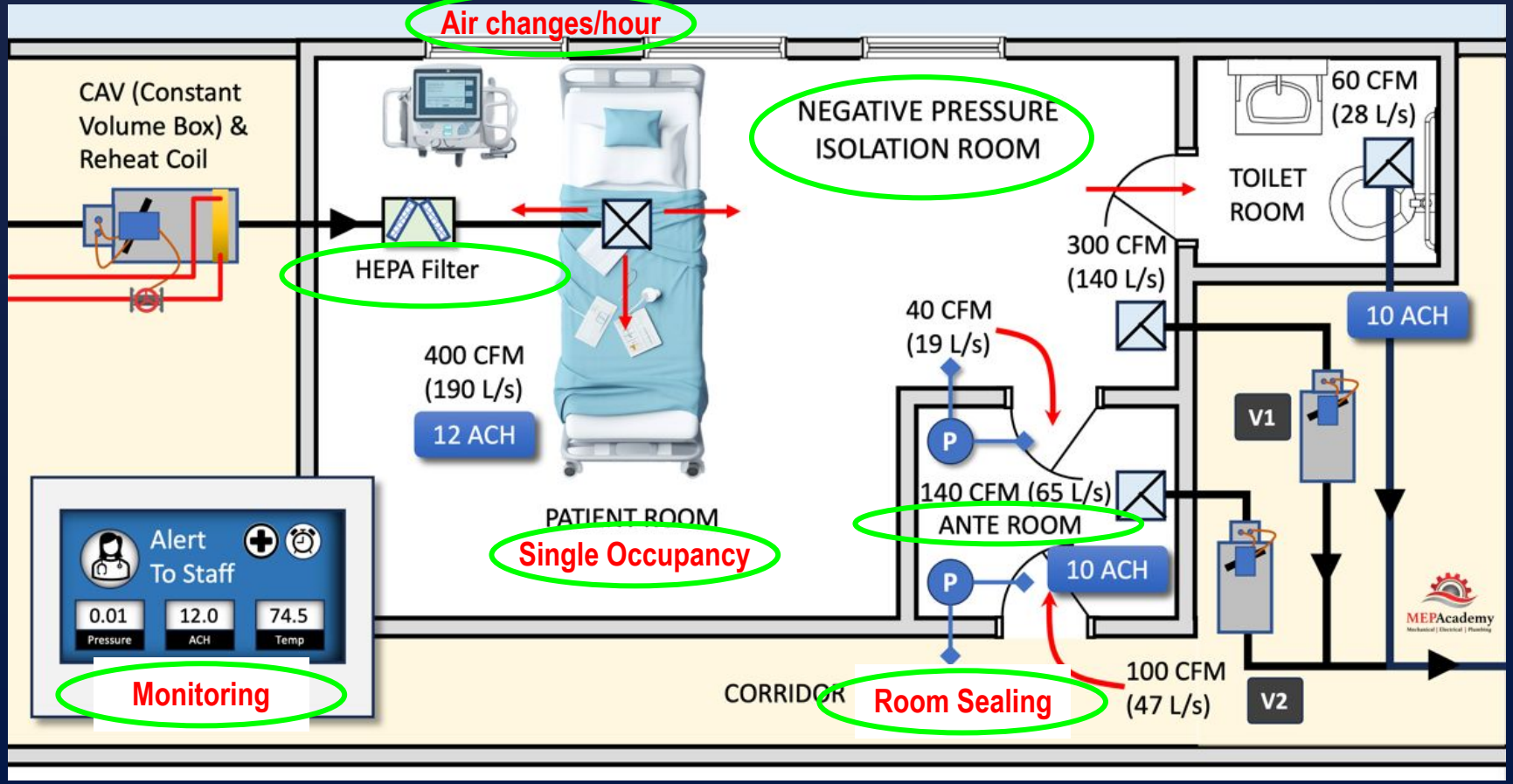
Hospitalized patients with:

- Known untreated pulmonary or laryngeal TB
- Pulmonary TB who are not responding to multiple-drug treatment
- Suspected pulmonary TB

Note: An A.I.I. room was previously called a Negative Pressure Isolation (NPI) room

Environmental controls: Airborne Infection Isolation (A.I.I.) room

What are the specific requirements of an A.I.I. room?



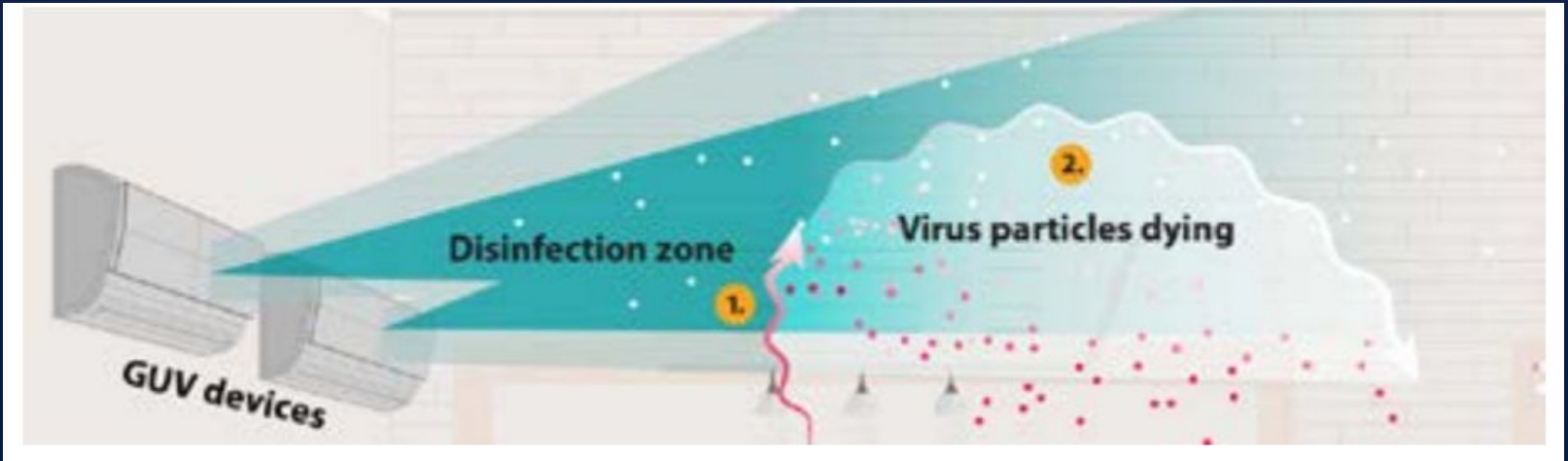
Environmental controls: Ventilation Systems

	Natural ventilation	Mixed-mode ventilation	Mechanical ventilation	Recirculated air with filtration
Balance of effects	★★★★☆	★★★★☆	★★★★☆	★★★☆☆
Resources required	★★★★☆	★★★☆☆	★☆☆☆☆	★★☆☆☆
Cost effectiveness	★★★★★	☆☆☆☆☆	☆☆☆☆☆	☆☆☆☆☆
Equity	★★★★☆	★★★☆☆	★★☆☆☆	★★☆☆☆
Acceptability	★★★★★	★★★★☆	★★★★☆	★★★★☆
Feasibility	★★★★☆	★★★☆☆	★★☆☆☆	★☆☆☆☆

Ultraviolet Germicidal Irradiation (UVGI)

- Used as a supplemental measure in areas with high risk of TB transmission to inactivate airborne *M. tb* bacilli.
- Not a substitute for proper ventilation.

Scheme of upper-room UVGI fixture with louvres



- Louvres are window blinds or shutters with horizontal slats that are angled to admit light and air

TB-IPC: Respiratory Protection

Respiratory Protection

Surgical Mask

- ASTM certified and FDA approved for surgery
- Fluid resistance and provides protection against large droplets, splashes, and bodily fluids
- Loosely-fitting
- Unreliable filtration protection against smaller airborne
- molecules
  Leakage during inhalation through mask's edges

VS

N95 Respirator

- NIOSH evaluated, tested, and approved
- Reduces exposure to large droplets and small aerosol
- particles
- Tight-fitting
  Must filter a minimum of 95% of airborne particlesagainst smaller
- airborne molecules
  Minimal leakage when properly fitted and worn

Respiratory Protection for HCWs

Circumstances

- While in the patient's room
- While accompanying a patient during transit
- While present during a procedure that induce coughing or aerosolization

Types

- **N95 respirator** filters particles ≥1 micrometer in diameter with ≥ 95% efficiency given flow rates up to 50 LPM.
  - Fit testing: To determine the most appropriate N95 respirator size that ensures tight seal
  - How often?
    - Optimal interval for repeat N95 respirator fit testing is uncertain.
    - Occupational Safety and Health Administration (O.S.H.A.) requires annual fit testing
      - However, this standard was designed to protect workers against industrial aerosols.
    - Evidence for annual N95 respirator fit testing in health care settings is limited
      - Good TB control outcomes have been reported by a program that did not test annually **Reference**: Welbel et al. *Am J Infect Control*. 2009. 37:668].
- **Powered Air-Purifying Respirators (PAPRs)** with H.E.P.A. filters may be used by HCWs who are unable to use an N95 respirator due to poor fit (for example, individuals with beards or those whose facial structure precludes a tight seal) or for extended procedures with a high risk of exposure.

Respiratory Protection for Patients

- **Surgical/Medical/Procedure face-mask**: Patients with suspected or confirmed infectious TB should be instructed to wear such a face-mask when they need to be transported outside of the A.I.I. room for essential medical procedures.
- **Source control**: Face-masks help to contain respiratory secretions at the source

Respiratory Protection for Visitors

- **Respirators**: Visitors should wear NIOSH-certified N95 particulate respirator while visiting patients with known or suspected active TB
- **Education**: HCWs should provide instructions on how to use the N95 respirator.

TB-IPC: Key Points - Clinical Approach

- **Step 1**: Assessing risk for TB to allow for early detection of suspect cases
- **Step 2**: Timely diagnostic evaluation of suspect cases
- **Step 3**: Clinical triaging of suspect PTB cases to reduce potential transmission
- **Step 4**: Respiratory isolation precautions of suspect cases
- **Step 5**: Source control measures of suspect cases
- **Step 6**: Prompt initiation of curative treatment of cases (presumptive or confirmed)
- **Step 7**: Contact investigation ASAP
- **Step 8**: Post-exposure prophylaxis and preventative treatment
- **Step 9**: Education and training of health-care personnel
- **Step 10**: Coordination with public health TB Control Program
- **Step 11**: Assessing compliance with the TB control plan
- **Step 12**: Surveillance


World TB day 2025
YES! WE CAN #ENDTB
Commit, Invest, Deliver!
END TB

Thank you